CLAIMS

1. A device for controlling a flow of emboli in an aorta of a patient, the device comprising:

an ultrasonic transducer, which is configured to transmit an ultrasonic beam into the aorta in a vicinity of a great origin of a neck vessel; and

a driver circuit, which is coupled to drive the ultrasonic transducer to generate the ultrasonic beam at a frequency and power level sufficient to divert at least a target fraction of the emboli of a given type and size away from the neck vessel.

2. The device according to claim 1, wherein the driver circuit is coupled to drive the ultrasonic transducer so as to reduce the flow of the emboli of the given size and type into the neck vessel by at least 80%.

3. The device according to claim 1, wherein the ultrasonic transducer is configured to transmit the ultrasonic beam so as to divert at least the target fraction of the emboli into the descending aorta.

4. The device according to claim 1, and comprising a holder, which is coupled to hold the ultrasonic transducer in proximity to the aorta.

5. The device according to claim 4, wherein the holder is adapted to be fixed to a retractor, which is used to spread a sternum of the patient during open heart surgery.

6. The device according to claim 4, wherein the holder is configured to hold the ultrasonic transducer on an anterior side of the aorta, so that the ultrasonic transducer transmits the ultrasonic beam in a posterior direction through the aorta.

7. The device according to claim 1, wherein the ultrasonic beam is unfocused.

8. The device according to claim 7, wherein the ultrasonic beam has an intensity in the aorta of at least 0.3 W/cm^2.

9. The device according to claim 7, wherein the ultrasonic beam diverges from the transducer through the aorta.

10. The device according to any of the preceding claims, and comprising a flexible coupler interposed between the transducer and the aorta.

11. The device according to claim 10, wherein the flexible coupler comprises at least one of a gel and a polymer.

12. The device according to claim 10, wherein the flexible coupler comprises a membrane, which contains a fluid for coupling the ultrasonic beam from the transducer to the aorta.

13. The device according to claim 12, and comprising a housing, which contains the transducer and the fluid, wherein the membrane forms at least part of the housing, the housing comprising a fluid port for injecting the fluid into the housing while the transducer is fixed in proximity to the aorta.

14. The device according to claim 13, and comprising a fluid circulation assembly coupled to the fluid port so as to cool the transducer by passage of the fluid through the housing.

15. The device according to claim 14, wherein the fluid circulation assembly comprises a closed circuit.

16. The device according to any of claims 1-9, and comprising an acoustic waveguide, which is adapted to convey the ultrasonic beam from the ultrasonic transducer to the aorta.

17. The device according to claim 16, wherein the acoustic waveguide has a distal end, which is configured to be brought into proximity with the aorta, and comprises a diverging optic in a vicinity of the distal end.

18. The device according to any of claims 1-9, wherein the driver circuit is adapted to actuate the ultrasonic transducer intermittently, responsively to variations in the flow of the emboli into the aorta.

19. The device according to claim 18, wherein the driver circuit is coupled to receive an indication of a heartbeat of the patient, and to actuate the ultrasonic transducer in synchronization with the heartbeat.

20. The device according to any of claims 1-9, wherein the driver circuit is adapted to actuate the ultrasonic transducer at a low power level during a first time period and at a high power level during a second time period, responsively to a variation in the flow of the emboli into the aorta associated with the second time period.

21. The device according to any of claims 1-9, wherein the driver circuit is operative to actuate the ultrasonic transducer with pulsed excitation.

22. A device for controlling a flow of emboli in an aorta of a patient, the device comprising:

an ultrasonic transducer, which is configured to transmit an ultrasonic beam; and

a holder, comprising a proximal end that is adapted to be fixed to a retractor used to spread a sternum of the patient during open heart surgery, and a distal end that is coupled to hold the ultrasonic transducer in proximity to the aorta so that the transducer transmits the ultrasonic beam into the aorta during the surgery.

23. An ultrasonic assembly, comprising:

an ultrasonic transducer, which is configured to transmit an ultrasonic beam;

a housing, which contains the ultrasonic transducer and comprises a coupler for coupling the ultrasonic beam into a target tissue;

cabling, having distal and proximal ends, the distal end coupled to the housing and comprising an electrical cable and fluid tubing; and

a cassette coupled to the proximal end of the cabling, the cassette comprising:

an electrical connector coupled to the electrical cable and adapted to be coupled to a power source for driving the transducer; and

a fluid reservoir coupled to the fluid tubing and containing a fluid for circulation through the housing via the tubing in order to cool the transducer.

24. The assembly according to claim 23, and comprising a console having a receptacle sized to receive the cassette, the console containing the power source for engaging the electrical connector and a mechanical drive for driving the circulation of the fluid.

25. The assembly according to claim 24, wherein the console is adapted to drive the circulation of the fluid without contacting the fluid, which flows in a closed circuit through the tubing.

26. The assembly according to claim 24, wherein the console comprises a cooling device, which is positioned to thermally engage the fluid reservoir when the cassette is inserted in the receptacle.

27. The assembly according to claim 24, wherein the cassette comprises an electronic device containing data regarding the assembly, and wherein the console comprises a wireless

reader, which is coupled to read the data from the electronic device when the cassette is inserted in the receptacle.

28. The assembly according to any of claims 23-27, wherein the fluid reservoir and tubing are filled with the fluid and then hermetically sealed and sterilized before use of the assembly.

29. A method for controlling a flow of emboli in an aorta of a patient, the method comprising transmitting an ultrasonic beam into the aorta in a vicinity of a great origin of a neck vessel with an ultrasonic frequency and power level sufficient to divert at least a target fraction of the emboli of a given type and size away from the neck vessel.

30. The method according to claim 29, wherein the ultrasonic frequency and power level are sufficient to reduce the flow of the emboli of the given size and type into the neck vessel by at least 80%.

31. The method according to claim 29, wherein transmitting the ultrasonic beam comprises diverting at least the target fraction of the emboli into the descending aorta.

32. The method according to claim 29, wherein transmitting the ultrasonic beam comprises positioning an ultrasonic transducer on an anterior side of the aorta, and transmitting the ultrasonic beam from the ultrasonic transducer in a posterior direction through the aorta.

33. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises transmitting an unfocused beam.

34. The method according to claim 33, wherein the ultrasonic beam has an intensity in the aorta of at least 0.3 W/cm^2.

35. The method according to claim 33, wherein transmitting the unfocused beam comprises transmitting a diverging beam.

36. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises positioning an ultrasonic transducer to transmit the beam, and interposing a flexible coupler between the transducer and the aorta so as to couple the beam into the aorta.

37. The method according to claim 36, wherein the flexible coupler comprises at least one of a gel and a polymer.

38. The method according to claim 36, wherein the flexible coupler comprises a membrane, which contains a fluid for coupling the ultrasonic beam from the transducer to the aorta.

39. The method according to claim 38, and comprising circulating the fluid through a housing of the transducer so as to cool the transducer.

40. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises conveying the ultrasonic beam from an ultrasonic transducer through an ultrasonic waveguide to the aorta.

41. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises actuating the ultrasonic beam intermittently, responsively to variations in the flow of the emboli into the aorta.

42. The method according to claim 41, wherein actuating the ultrasonic beam comprises receiving an indication of a heartbeat of the patient, and actuating the ultrasonic beam in synchronization with the heartbeat.

43. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises actuating the ultrasonic transducer at a low power level during a first time period and at a high power level during a second time period, responsively to a variation in the flow of the emboli into the aorta associated with the second time period.

44. The method according to any of claims 29-32, wherein transmitting the ultrasonic beam comprises actuating the ultrasonic beam with pulsed excitation.